

WINCOMM

Enhancement with Flight Validation of Aviation Datalinks/Network for Weather Dissemination

WxAP Briefing

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Scenarios

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Commercial Transport

General Aviation

International/Oceanic

Commercial Transport

Objectives

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Demonstrate a path to implementation for the following value added objectives:

- Dissemination of data from own ship turbulence events to other aircraft and ground users.
- Receive, process and deliver valid turbulence warnings to the cockpit from other equipped aircraft.
- Receive and display Flight Information Service Broadcast (FIS-B) ground-air weather products.

Architecture Design

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- Due to the near-term focus of this WINCOMM task it was necessary to select datalinks that already reside on commercial transport aircraft or were on a path for installation in the near future.
- No single datalink can currently satisfy the project requirements for air-to-air, ground-to-air broadcast, and air-to-ground two-way communication to this class of aircraft. It was therefore necessary to design a hybrid communication architecture to meet the project objectives

Objectives 1&2

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- Dissemination of data from own ship turbulence events to other aircraft and ground users.
- Receive, process and deliver valid turbulence warnings to the cockpit from other equipped aircraft.

Need an Air-to-Air link

Air-to-Air

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A natural match for air-to-air communication is one of the Automatic Dependent Surveillance Broadcast (ADS-B) links.

- On July 1, 2002, the FAA announced the ADS-B link decision, selecting the 1090 Extended Squitter link for air carrier and private/commercial operators of high performance aircraft

1090ES datalink was selected by WINCOMM to fulfill the air-to-air datalink requirements for the transmission of turbulence alerts.

Turbulence Alert Message

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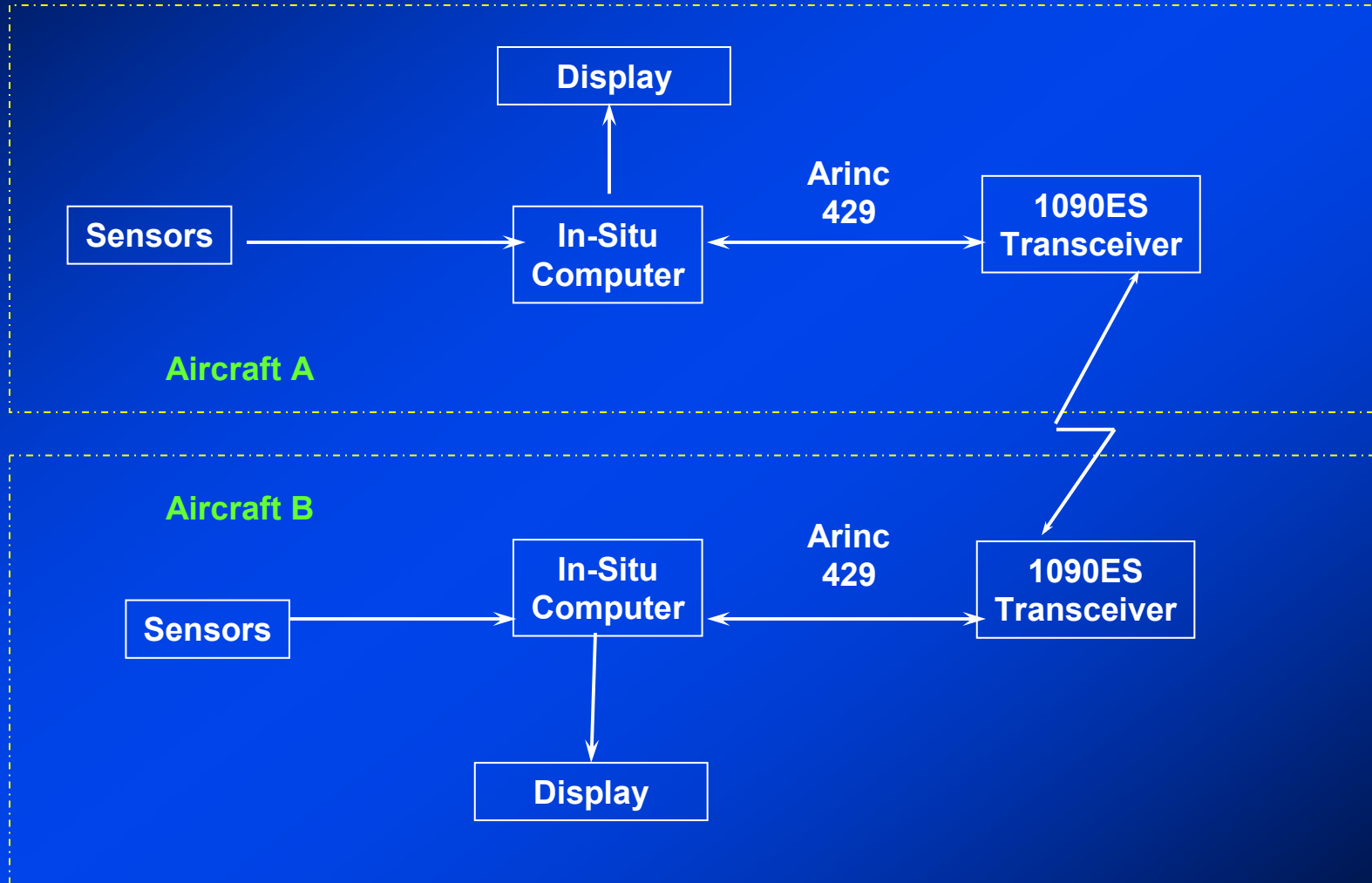


- The turbulence alert message will consist of the following parameters:
 1. Time
 2. Latitude
 3. Longitude
 4. Altitude
 5. Processed Normal Load
 6. Processed Aircraft Constant
- Standard ADS-B messages already contain the first four parameters, it is only necessary to broadcast two additional parameters. These two additional parameters are each eight bits long, totaling an additional 16 bits to be transmitted. The additional parameters will be formatted as a payload to a standard ADS-B message, in compliance with DO-260A.

1090ES Data Flow

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Objective 1&3

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- Dissemination of data from own ship turbulence events to other aircraft **and ground users.**
- **Receive and display Flight Information Service Broadcast (FIS-B) ground-air weather products.**
- This objective requires at a minimum a ground-to-air broadcast link. WINCOMM's experiments will also include an air-to-ground request message, in order to facilitate the broadcast of additional value-added weather products, and a reliable air-ground turbulence alert message.
- With the additional requirements we now need a *bi-directional air-to ground datalink.*

Bi-Directional Air-Ground link

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The two bi-directional datalinks on the horizon for near-term use are VDL Mode 2 and VDL Mode 3.

- VDL Mode 3 uses a Time Division Multiple Access (TDMA) scheme, which allows a number of users to access a single Radio Frequency (RF) channel by dividing a 25 kHz channel into four time slots and allocating each time slot to one user/application. The channel separation can be utilized to effectively separate non-critical data, weather information, from critical data, Controller Pilot DataLink Communication (CPDLC).
- VDL Mode 3 was designed with a ground broadcast mode, which will facilitate FIS-B communications.

VDL Mode 3 Messages

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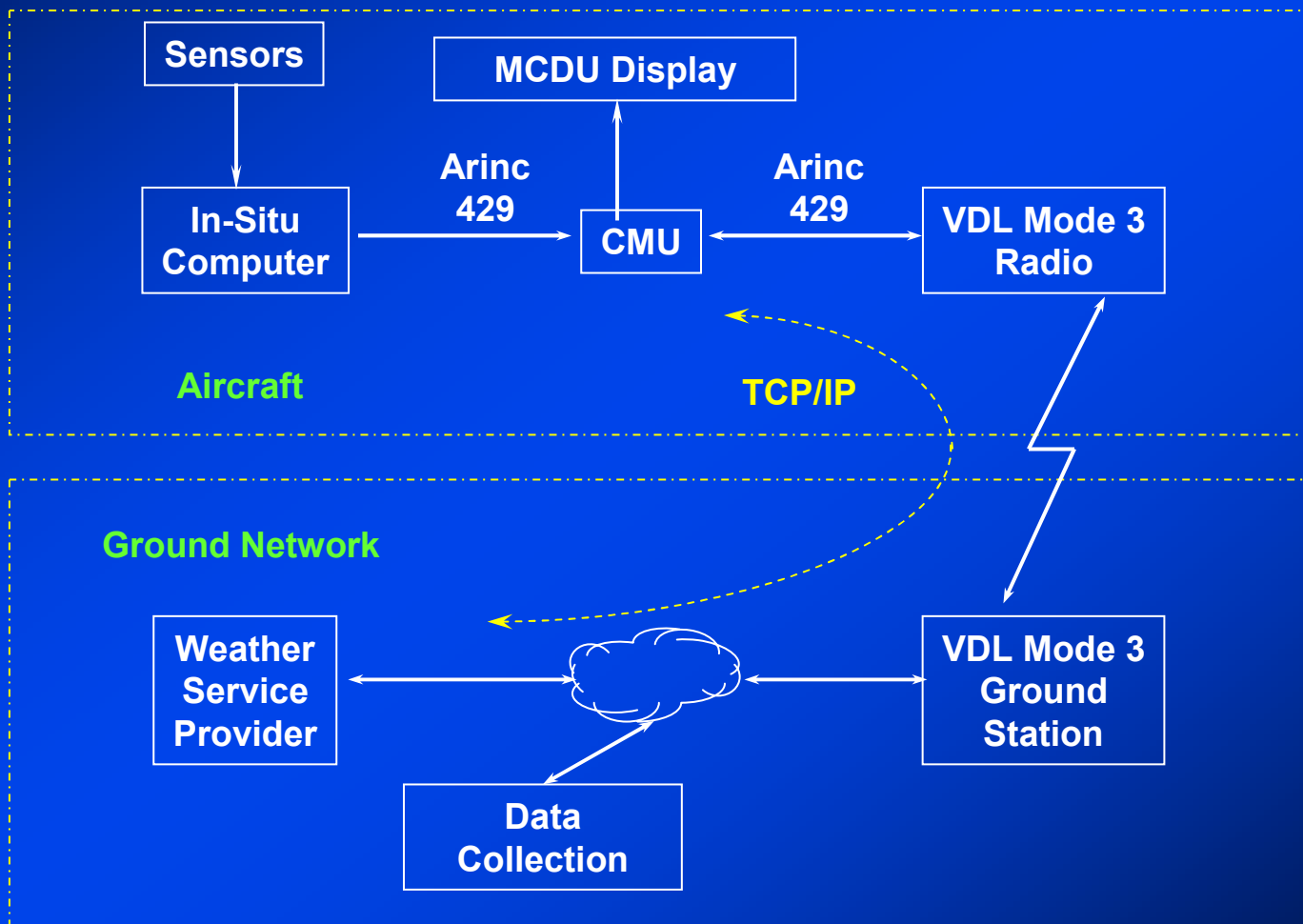


- Reliable Air-ground turbulence messages
- Reliable Air-ground message for requesting additional graphical weather products
- Broadcast Ground-Air FIS-B weather products

VDL Mode 3 Data Flow

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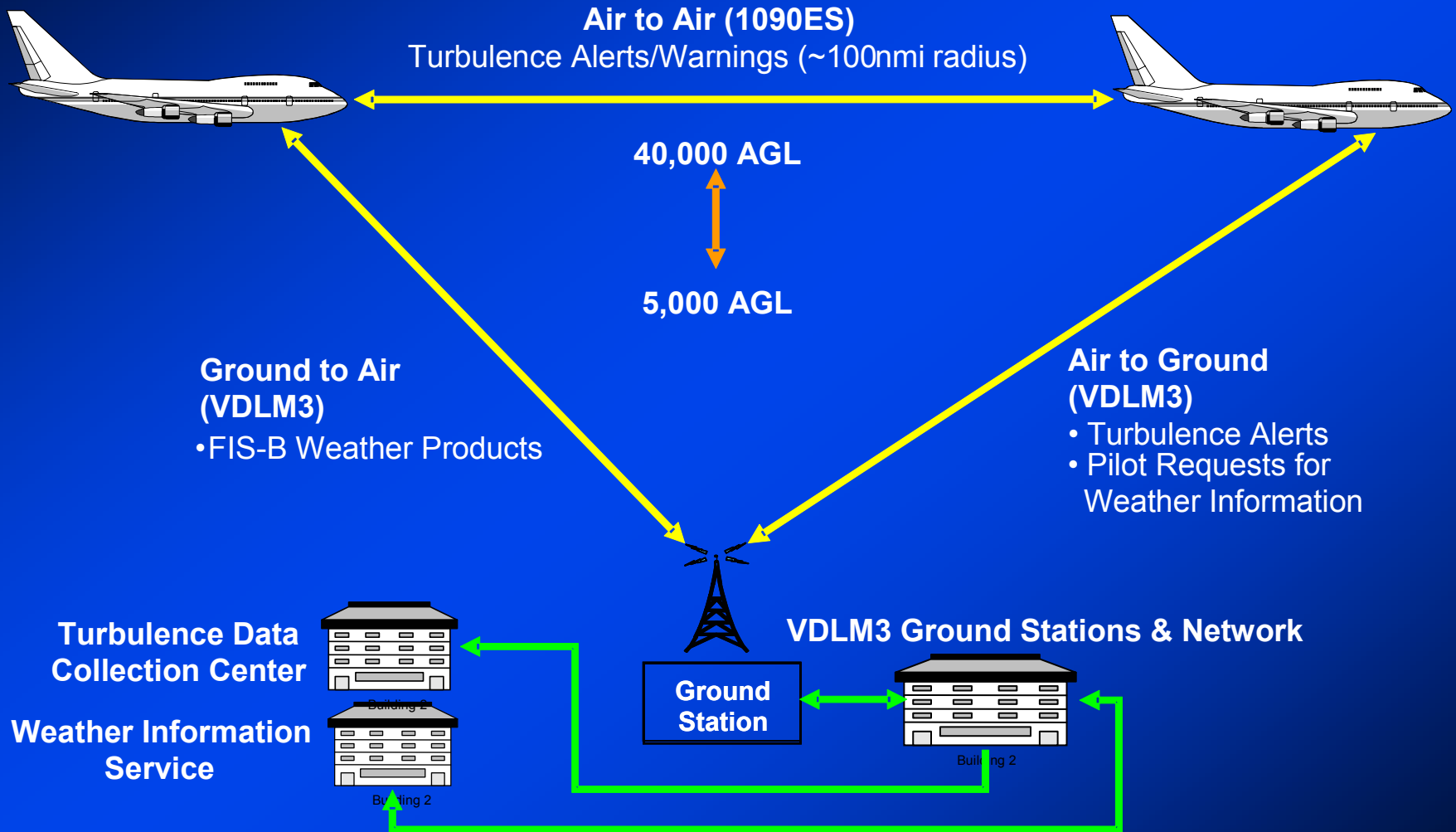
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Commercial Transport Architecture

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General Aviation

Objectives

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Demonstrate a path to implementation for the following value added objectives:

- Broadcast of data from an onboard atmospheric sensor to other aircraft and ground users.
- Receive and display information from other airborne atmospheric sensors.
- Receive and display ground-air Flight Information Service Broadcast (FIS-B) ground-air weather products.

Datalink Selection

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To satisfy the objectives, we need a communications system which is capable of Air-to-Air, Air-to-Ground broadcast, and Ground-to-Air broadcast.

UNIVERSAL ACCESS TRANSCEIVER (UAT)

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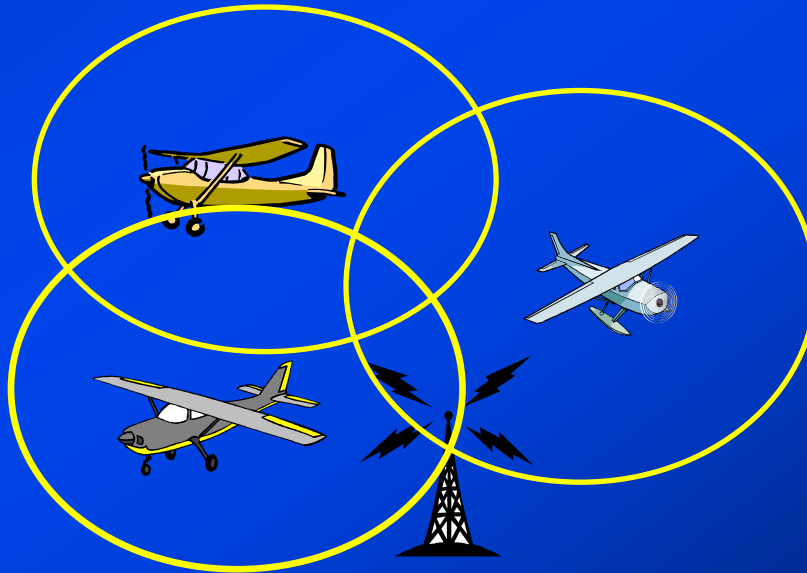
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- FAA Link Decision specifies UAT for General Aviation (GA) aircraft
- Multi-purpose aeronautical data link intended to support:
 - Automatic Dependent Surveillance-Broadcast (ADS-B),
 - Flight Information Service-Broadcast (FIS-B),
 - Traffic Information Service-Broadcast (TIS-B).
- Transmits and receives in the aeronautical radio navigation frequency band (978 MHz).
- Air-Ground, Air-Air & Ground-Air Capability.



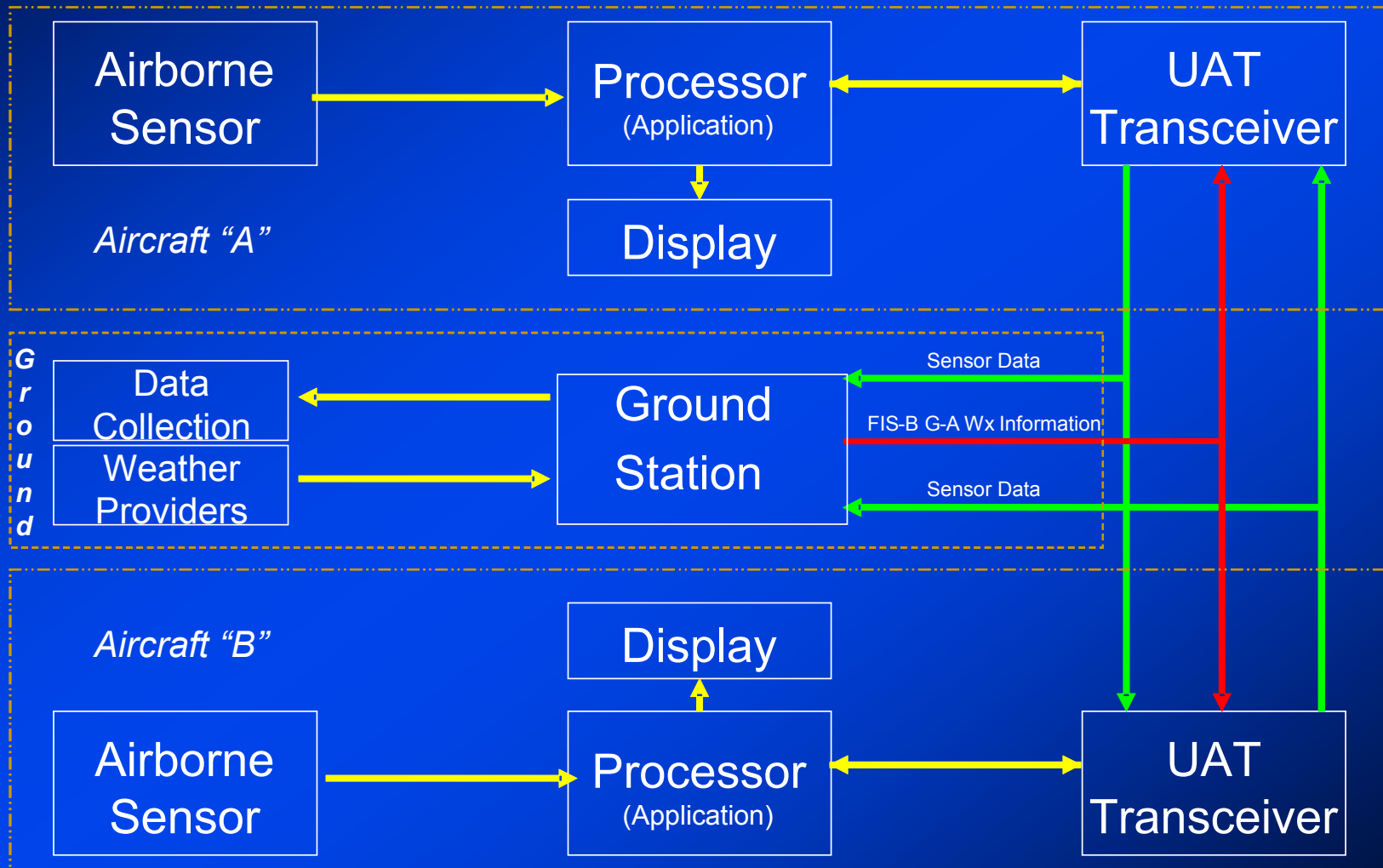
- Broadcasts latitude, longitude, altitude, velocity with high degree of accuracy (GPS).
- Transmits long ranges (~100 miles in all directions).
- Equipped aircraft receives air and ground broadcasts and displays weather and traffic information.



UAT Data Flow

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UAT Messages

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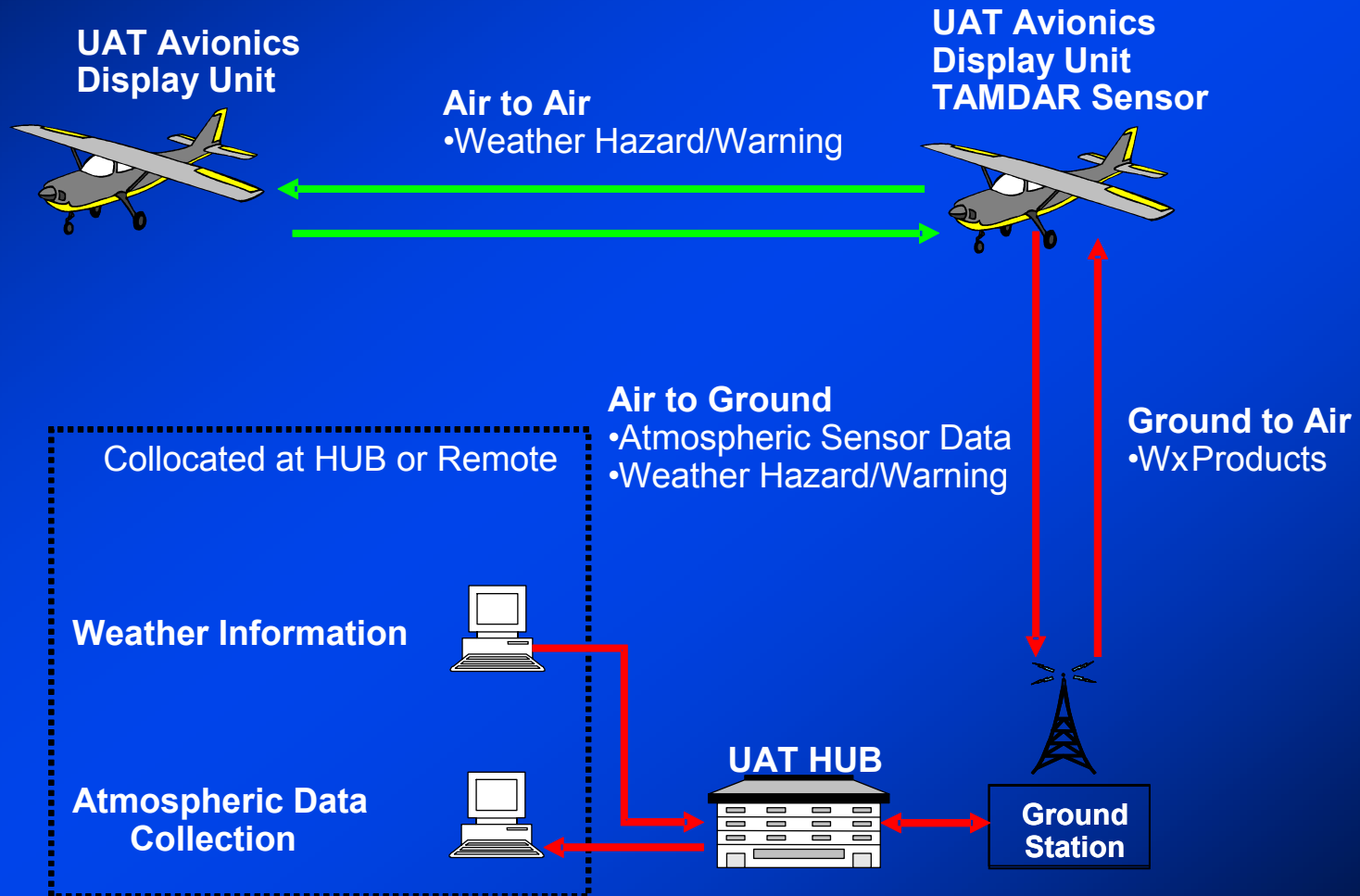


- Broadcast Air-Air & Air-Ground atmospheric sensor data
 - Temperature
 - Wind Direction
 - Turbulence
 - Wind Speed
 - Humidity
 - Airspeed
 - Icing
- Additional Broadcast Ground-Air FIS-B weather products

General Aviation Architecture

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International/Oceanic

Objectives

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- Receive, process and deliver valid turbulence warnings to the cockpit from other equipped aircraft.
- Receive and display Flight Information Service Broadcast (FIS-B) ground-air weather products.

Datalink Selection

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Natural datalink choice for this flight environment is a satellite-based solution.

Two-way satellite service does not provide direct Air-Air communications, but turbulence events can be relayed through ground station up to additional aircraft.

Swift-64

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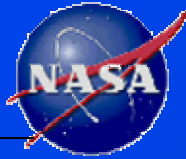


- INMARSAT
 - Worldwide network of ground stations and satellites.
 - Swift-64
 - 64Kbps in-flight communications service.
 - Two types of services
 - Mobile ISDN
 - Mobile Packet Data Services (MPDS)
- SITA
 - Provides INMARSAT/Swift-64 Service
 - Extensive ground network
 - Partner of INMARSAT

Swift-64 Messages

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- Turbulence Data
 - Disseminate to other aircraft or ground.
 - Receive and display warnings to the cockpit from other aircraft.
- Graphical Weather Products
 - Receive, process and display weather products.
- Cockpit Warnings and Alerts
 - Receive, process and display warning and alerts.
- Air Traffic Control (ATC) Data.
 - Receive and process ATC information from ground stations.
 - Verify that ATC information can be transferred reliably and securely.

Research Issues

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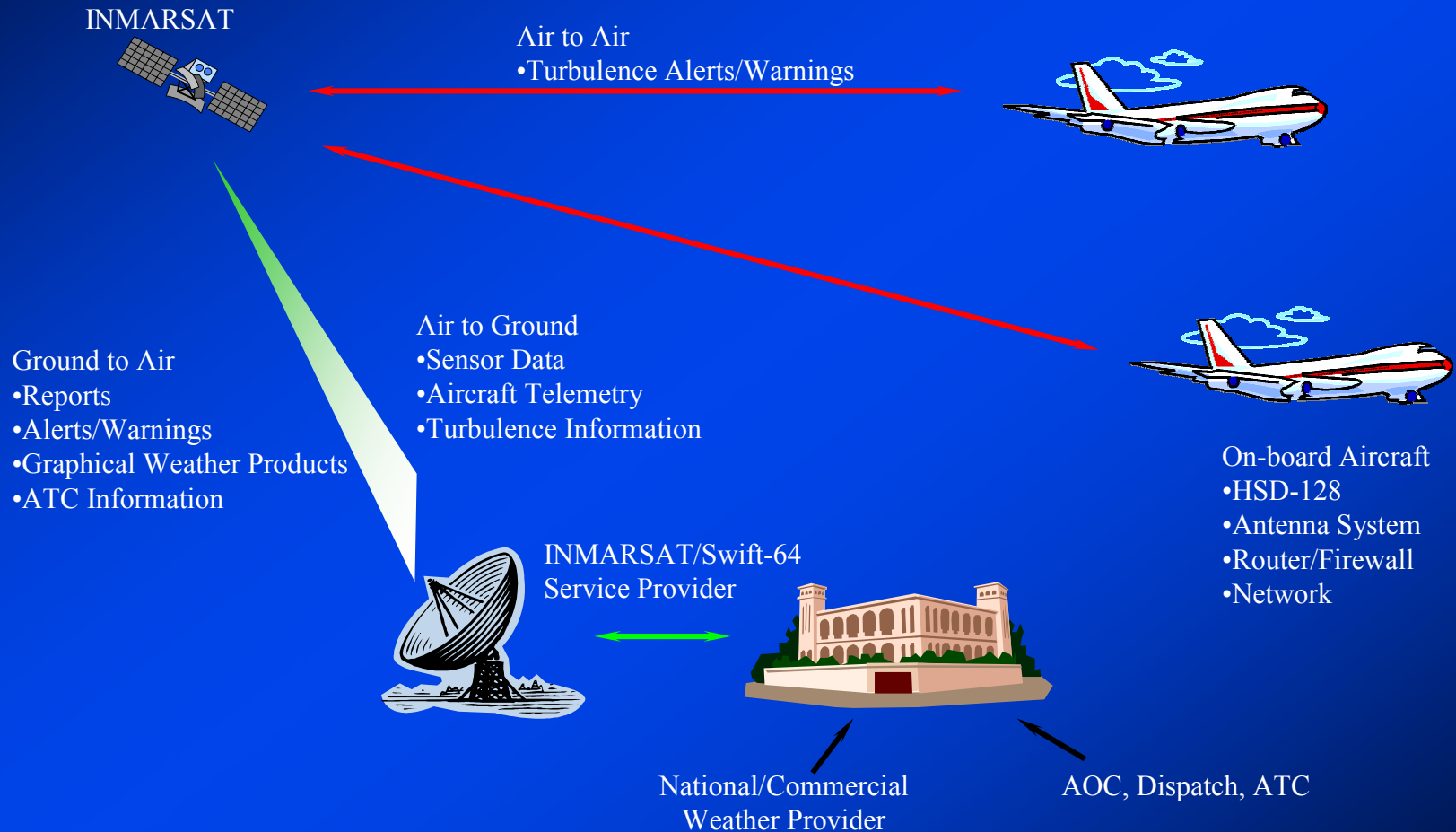


- Quality of Service (QoS)
 - Cockpit data must maintain a higher level of priority than the cabin data
 - Differentiate between cabin data, weather data or ATC data.
 - Determine changes to router OS for QoS and determine how effectively the OS handles QoS.
- Link Availability
 - Must maintain communications with the cockpit at all times.
 - Determine if INMARSAT/Swift-64 coverage is extensive enough to cover the majority of the flight patterns.
 - Determine if ground networks be relied upon for cheaper content delivery.
- Security
 - Protect the shared link from unauthorized users.
 - Apply lessons learned from the terrestrial Internet.
 - Application of security devices (e.g., encryptors, VPN, firewalls) to the on-board network.

International/Oceanic Architecture

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Summary

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- All equipment modifications will be software based in order to allow the reception and transmission of the additional messages.
- All modifications will be made within the accepted standards or in a manner consistent with the standards.
- These changes are being worked closely with industry partners with a path toward certification.